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Aggregate Resources Inventory of the Town of Elliot Lake Algoma District Northern Ontario

By Staff of the Engineering and Terrain Geology Section
Ontario Geological Survey

1984

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Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

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ABSTRACT

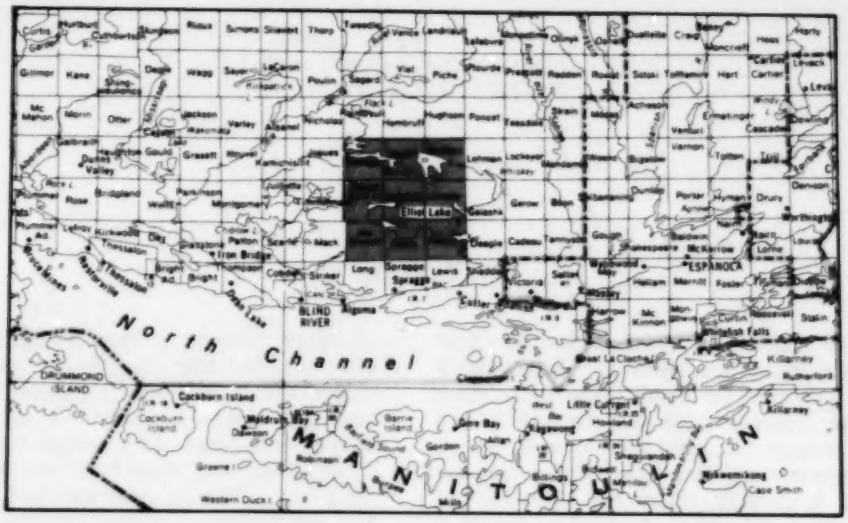

Figure 1 - Key Map Showing the Location of the Town of Elliot Lake, Scale 1: 1 584 000.

This report includes an inventory and evaluation of sand and gravel, as well as bedrock resources of the Town of Elliot Lake in the District of Algoma (Figure 1). The report is based on previous studies in the area and on field investigations undertaken for the preparation of this report. Funding for the preparation of the report was provided by the Ontario Ministry of Natural Resources.

A total of five sand and gravel deposits in the project area have been selected as resource areas of primary significance. The resource areas occupy a total of 1670 acres (680 ha), of which an estimated 1220 acres (495 ha) are available for extraction purposes. The total sand and gravel resource tonnage is estimated to be 58 million tons (53 million tonnes).

Good quality crushable gravel is available in Resource Areas 1 through 4. Testing of material from Resource Area 5 shows the sand and gravel to be a good pit-run source. Crushable material may also be present. There are also a number of secondary deposits which contain significant quantities of sand and gravel. Further testing and evaluation are required for most of these deposits.

Extractive activity in the study area has been concentrated along the Highway 108 corridor. As supplies adjacent to the highway diminished, more remote deposits were opened for extraction.

The Town of Elliot Lake is underlain by early Precambrian metavolcanic, metasedimentary, and granitic rock, as well as folded Huronian sediments and Nipissing Diabase. The latter is the only rock type believed suitable for crushed stone production. Drift cover in the area is extremely variable. Only thinly drift-covered areas of diabase have been selected for possible resource protection. The resource areas occupy a total of 12,000 acres (4850 ha), of which 11,000 acres (4450 ha) are available for extraction. Assuming an average quarriable depth of 60 feet (18 m), approximately 2700 million tons (2450 million tonnes) of bedrock are thus available.

Selected Resource Areas are not intended to be permanent single, land use units which must be incorporated in an official planing document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

AGGREGATE RESOURCES INVENTORY OF THE TOWN OF ELLIOT LAKE[1]

BY
STAFF OF THE ENGINEERING
AND TERRAIN GEOLOGY SECTION

INTRODUCTION

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1981, the total tonnage of mineral aggregates extracted was 121 million tons (110 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1982).

Although mineral aggregate deposits are plentiful in Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand, gravel and crushed bedrock. The most recent information available has been used to prepare the report. As new information becomes available, revisions may be necessary.

[1] Manuscript accepted for publication by Chief Engineering and Terrain Geology Section, May 13, 1983.

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PART I – INVENTORY METHODS

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References) as well as field examination of potential resource areas. Field methods included the examination of natural and man-made exposures of granular material. Most observations were made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites included estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations were also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing and hand-augering techniques were used to assess subsurface materials. Airphotos at various scales were used to determine the continuity of deposits, especially in areas where information is limited.

Deposits with potential for further extractive development or those where existing data are scarce, were studied in greater detail. Representative layers in these deposits were sampled from existing pit faces and hand dug test holes. The samples were analysed for grain size distribution and in some cases for petrographic assemblage. Most analyses were performed in the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications. The symbols for and locations of sample and test hole sites are noted on Map 1.

In the office, the field data were supplemented by pit information on file with the Soils and Aggregate Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The locations of additional sources were obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, were used in some areas to corroborate thickness estimates or to indicate the presence of buried granular material. These records were used only in conjunction with other evidence. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) in extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore,

such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 are calculated in the following way. Two successive subtractions are made from the total area. Column 3 accounts for the number of acres unavailable due to the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas that have previously been extracted. The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multipled by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

Reserve estimates are calculated for deposits of primary significance. Reserve estimates for deposits of secondary and tertiary significance are not calculated in Table 3, however the aggregate potential of these deposits is discussed in the report.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of bedrock formation overlain by less than 25 feet (8 m) of unconsolidated overburden is determined from bedrock geology maps and from the interpretation of available subsurface data. The measured extent of such areas is then multipled by the estimated quarriable thickness of the rock unit. In most cases a standardized estimate of a quarriable thickness of 60 feet (18 m) is used. Although the thickness of the Precambrian bedrock units in northern Ontario are all probably considerably greater, the 60-foot (18 m) value is considered an appropriate estimate of the maximum thickness of material that can be economically and technologically extracted from a given quarry face. Volume estimates are then multiplied by 3700 (the estimated weight, the Imperial tons, of a one-foot (0.3 m) thick section of Precambrian rock one acre (0.4 ha) in extent, assuming a bulk density of 170 pounds per cubic foot (2729 kg per cubic metre)). Resources of diabase are calculated using a bulk density estimate of 190 pounds per cubic foot (3050 kg per cubic metre) or approximately 4100 tons per acre (9200 tonnes per hectare). Quartzite, greywacke and conglomerate resources are calculated using a bulk density estimate of 165 pounds per cubic foot (2650 kg per cubic metre) or approximately 3600 tons per acre (8100 tonnes per hectare).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel as well as bedrock-derived aggregate are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p. 7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

PART II - DATA PRESENTATION AND INTERPRETATION

Three maps, each portraying a different aspect of the aggregate resources in the study area, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resources Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources", shows the distribution of bedrock lithologies, the distribution of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

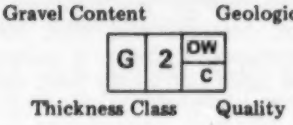
Map 1 is derived directly from existing surficial geology maps of the area or from airphoto interpretation in areas where surficial mapping is incomplete. It shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

On the map, gravel deposits are indicated by dark brown shading while sand deposits are shaded light brown. The present level of extractive activity is also indicated. Pits are shown by a solid dot and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner and location of the pit, as well as the estimated face height, percentage gravel and pit status.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for every deposit shown on Map 1. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate makes up less than 35 percent of the whole deposit. "G" indicates that the aggregate probably contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identify the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identify the main quality limitations that may be present in the deposit as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The data from which these symbols are derived has been plotted on grain size distribution graphs. The relative amounts of gravel, sand, and silt and clay in the sampled material are shown graphically by the sub-

division of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol.

MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resources areas are first delineated by geological boundaries and then classified into three levels of significance: primary, secondary, and tertiary. Each area of primary significance is assessed as to its probable relative value as a resource in the report area and is given a deposit number which denotes its ranking order in that area. All such deposits are shown by dark red shading on Map 2.

Selected Aggregate Resource Areas of primary significance are not permanent, single, land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by light red shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Although deposits of secondary significance are not considered to be the "best" resource areas in the report area, they may contain large quantities of sand and gravel and should be considered as part of the aggregate supply of the area.

Areas of tertiary significance are outlined on the map by a solid line but have no shading. They are neither rated nor considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the report area is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

DEPOSIT SIZE

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6 m) and containing more than 35 percent crushable gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

AGGREGATE QUALITY

The limitations of natural aggregates for various uses result from variations in the lithology of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S), fines (C), oversize (O) and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content, (G or S), indicates the suitability of aggregate for various uses. Deposits containing at least 35 percent

gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (or high silt and clay content) may severely limit the potential use of an aggregate. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock types determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high-quality uses such as concrete and asphalt. Similarly, highly weathered, very porous and friable rock can restrict the quality of an aggregate. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations.

Analyses of unprocessed samples obtained from test holes or pits have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products: Granular Base Course A, B and C; and Hot-Laid Asphaltic Sand Nos. 1, 2, 3, 4, 5, 6 and 8. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

LOCATION AND SETTING

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas, because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, powerlines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits and bedrock resource areas with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report, but readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the

local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain roughly at the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology maps, water well data from the Ontario Ministry of the Environment, drilling assessment data from the Ontario Ministry of Natural Resources and from the Northern Ontario Engineering Geology Terrain Studies produced for the Ontario Geological Survey. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Areas where bedrock outcrops, or is within 3 feet (1 m) of the ground surface are indicated by dark blue shading. Isolated bedrock outcrops which lie outside these areas are indicated by a black "X" symbol. These areas constitute potential resource areas of primary significance, because of their easy access. Areas where the bedrock is covered by 3 to 25 feet (1 to 8 m) of drift are indicated by light blue shading. Quarrying is possible in this depth of overburden and these also represent potential resource areas. Outside the delineated areas of thin drift cover, the bedrock is generally overlain by more than 25 feet (8 m) of drift. These areas constitute resources which have extractive value only in specific circumstances and it is unlikely these areas will constitute resource areas of economic significance.

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the report area. All known quarries are shown by a dot symbol and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location and an estimate of face height. One additional symbol appears on the map: an open dot indicates the location of a selected drill hole which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and Communications. The main characteristics of the bedrock units found in the study area are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations. Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of bedrock resource areas has been restricted to a single level of significance. Two factors support this approach. First, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and second, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances

can be considered. These factors allow the identification of alternative sites having similar development potential. The selected areas are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

It should be stressed, that the Precambrian Shield rocks in northern Ontario are generally more complex and variable than the Paleozoic rocks of southern Ontario. They often show wide variations in mineralogy, texture (grain size) and degree of weathering, even within specific rock types and over relatively short distances. As these factors are considered important in determining the suitability of the bedrock for use as aggregate, the aggregate potential may also vary considerably from location to location.

Careful selection is especially important if the bedrock is to be used as concrete aggregate. Deleterious chemical reactions may develop in the concrete which can lead to its eventual deterioration. Fortunately, these chemical reactions should not influence the use of bedrock-derived aggregate for hot-laid asphaltic and road-base material. However, highly weathered, very porous and friable rock should be avoided for all uses.

For these reasons, the total area selected as a bedrock resource should not be considered acceptable for aggregate use. They are, however, areas in which the probability of finding a supply of acceptable aggregate is considered most likely.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such a Resource Area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

PART III - ASSESSMENT OF AGGREGATE RESOURCES IN THE TOWN OF ELLIOT LAKE

LOCATION AND POPULATION

The Town of Elliot Lake is located in the southeastern part of the District of Algoma, approximately 13 miles (21 km) north of Lake Huron (Figure 1). Access to the area is provided by road and aircraft. King's Highway 108 runs through the study area with mine and timber roads branching off to the east and west. There is an airstrip south of the Town of Elliot Lake.

The Elliot Lake Area consists of nine geographic townships which together form the Corporation of the Town of Elliot Lake. Included in the Corporation are Beange, Bouck, Buckles, Bolger, Gunterman, Joubin, McGiverin, Proctor, and Esten geographic townships; referred to hereafter as townships.

These townships are shown on the following map sheets of the National Topographic System at a scale of 1:50 000; Elliot Lake (41 J/7), Whiskey Lake (41 J/8), Madawanson Lake (41 J/9), and Rawhide Lake (41 J/10). The nine townships cover an area of 205,434 acres (83 139 ha).

Most of the population is located in Gunterman Township, with minor concentrations in Bouck and Buckles Townships (L. Burling, Deputy Clerk, Town of Elliot Lake, personal communication, 1981). The total population of Elliot Lake has more than doubled in the last eight years, increasing from 8244 in 1975 to 18,670 in 1982 (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics, and Intergovernmental Affairs 1976). Growth in the town's population reflects the growth in the uranium mining industry in the area. As growth occurs in the local mining industry and the population of the area continues to increase, the demand for construction aggregates for urban development and mine construction is likely to increase.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The physiography and distribution of surface material, including the sand and gravel deposits shown on Map 1, are the result of glacial activity which occurred during the Great Ice Age. Striae, chattermarks, and roches moutonnees, as observed by Robertson (1968), indicate that the direction of ice flow was to the southwest. The ice mass removed the pre-existing soil, and bedrock outcrops were scoured, rounded, polished and grooved (Robertson 1968). Subsequent glacial deposits include a patchy veneer of basal till with glaciofluvial outwash deposits in bedrock depressions and meltwater drainage paths.

The basal till is a silty, sandy till with boulders up to 6 feet (2 m) in diameter. Where present, the basal till rests directly on the bedrock surface. Deposits of this till are generally thin, but locally can exceed 125 feet (38 m) thick (Golder Associates 1981). The larger, deeper deposits of till are generally found on the stoss side of bedrock knobs. The basal till is not used for road-building aggregate because of its high fines content. It is, however, of local importance for tailings-dam core construction. Although this material is not shown on Maps 1 and 2, till has been mined in pits 24 to 29 north of Crotch Lake and west of Quirke Lake in Bouck and Gunterman Townships.

Most of the sand and gravel in the Elliot Lake Area was deposited as glaciofluvial outwash and is generally found along bedrock controlled valleys. As the ice front retreated, sediment-laden meltwaters flowed southward through existing valleys and deposited sand and gravel. These deposits can exhibit a variable structure and/or grain size because of the irregular bedrock topography and the presence of blocks of ice during deposition. The sand and gravel is usually stratified, but may be structureless with only a slight imbrication of clasts. Grain size varies from sand to boulders. The sediment tends to be coarser where deposited close to the ice front or near bedrock surfaces.

There are minor ice-contact features in the Elliot Lake Area. Small esker ridges were observed within the outwash deposits situated east of Dunlop Lake, south of McCabe Lake and north of Mathers and Christie Lakes. These deposits are too small to be shown on Map 1, but should be noted as possibly containing good aggregate material.

Most of the sand and gravel is derived from the local bedrock. Because much of the bedrock

in the area has radioactive mineralization, the sand and gravel deposits may also be radioactive. Testing for radon gas and other products of radioactive decay of uranium is recommended before any of the aggregate is used for structural concrete or building foundation backfill. This should be done on a site specific basis.

EXTRACTIVE ACTIVITY

Extractive activity in the Elliot Lake Area has been concentrated along the Highway 108 corridor. Many pits were opened in order to provide material for highway, mine road, and original town site construction. A large percentage of these pits are now both depleted and abandoned. Active pits are located in Selected Sand and Gravel Resource Areas 1, 2 and 3 as well as in the secondary deposits.

All aggregate extraction on Crown Land is regulated by the Ontario Ministry of Natural Resources under The Mining Act. One-year quarry permits are issued and may be renewed annually according to the regulations set out in the Act.

SELECTED SAND AND GRAVEL RESOURCE AREAS

The sand and gravel deposits selected for possible resource protection in the Town of Elliot Lake are shown on Map 2. At the primary level, an estimated 1220 acres (495 ha) currently available for extraction, contain sand and gravel resources of approximately 58 million tons (53 million tonnes). These values may vary because the irregular bedrock topography makes deposit depths and tonnage estimates difficult.

The general quality of the coarse aggregate is good to excellent. The main components include quartzite, ortho-quartzite, arkosic sandstone, granite, diorite, and gabbro. Poorer quality rock types include brittle granites and soft or porous volcanics. Petrographic analyses carried out on samples from the area indicated that the gravel deposits are suitable for the production of paving and structural concrete, Hot-Laid (H.L.) Nos. 3, 4, 5, 6 and 8, and all granular products. This material may also be a good source of skid resistant aggregate.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 is a small outwash deposit in the northwest part of Bouck Township. An active source (pit 2), located in this deposit, has produced Granular Base Course A. A petrographic analysis performed on a sample from a stockpile of this material showed that the aggregate is of sufficient quality to be used for all road construction products except H.L. 1. The only limiting factor associated with this deposit is the occurrence of quartzite boulders. This hard oversize material may require additional processing.

Resource Area 1 occupies a total of 120 acres (48 ha), of which approximately 60 acres (24 ha) are available for extraction. Assuming an average deposit thickness of 25 feet (8 m), there are approximately 4 million tons (4 million tonnes) of sand and gravel available.

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Sand and Gravel Resource Area 2 is an east-west trending outwash deposit, north of Manfred Lake in Bouck Township. This deposit is an excellent source of crushable material. Poorer quality materials within the deposit include 2 to 3 percent weathered igneous particles and 1 to 2 percent shale. However, the material is still acceptable for most granular products.

Resource Area 2 has a total area of 120 acres (48 ha), of which 85 acres (34 ha) are presently available for extraction. Assuming an average deposit depth of 25 feet (8 m), an estimated 5 million tons (4 million tonnes) of sand and gravel are available for use.

SELECTED SAND AND GRAVEL RESOURCE AREA 3

Selected Sand and Gravel Resource Area 3 is a large outwash deposit east of Summers Lake in Beange and Bouck Townships. This deposit is the location of five pits which operate on an active-on-demand basis. A wide variety of construction materials has been produced from this deposit. The aggregate is generally good quality crushable material, but may contain silty fine sand pockets as was observed in pit 22. The deposit is locally important because of its excellent access and its proximity to Highway 108, the Elliot Lake townsite and various mines.

The depth to bedrock under this deposit is irregular. On average, the deposit is 18 feet (5 m) deep. The Resource Area occupies a total of

950 acres (385 ha), of which approximately 650 acres (265 ha) are available for extraction. Thus, there are approximately 29 million tons (26 million tonnes) of sand and gravel available.

SELECTED SAND AND GRAVEL RESOURCE AREA 4

Sand and Gravel Resource Area 4 is located east of Gullbeak Lake in Bolger Township. Although not accessible by road at present, this deposit is within 5 miles (8 km) of the Elliot Lake townsite. To date, there has been no extractive activity in this deposit.

Hand dug test holes, EL-TH-1 and EL-TH-2, showed the deposit to be clean outwash sand and gravel. Grain size analyses on samples taken from these test holes showed the material to contain over 50 percent gravel (Figure 4). However, these samples were taken from beds (topset beds) containing a higher percentage gravel and may not be representative of the overall gravel content of the deposit. In both samples, there was less than one percent fines.

Local topography indicates that the deposit may exceed 25 feet (8 m) in depth. However, the irregular bedrock topography makes depth estimation difficult. Further study of this deposit might include geophysical investigation, such as hammer seismic, in order to determine deposit thicknesses at various locations. The material in this deposit may be of sufficient quality to produce coarse granular products.

Resource Area 4 occupies a total of 305 acres (123 ha), of which 275 acres (111 ha) are available for extraction. Assuming an average depth of 20 feet (6 m), approximately 14 million tons (13 million tonnes) of sand and gravel are available.

SELECTED SAND AND GRAVEL RESOURCE AREA 5

Sand and Gravel Resource Area 5 is in Esten Township between the Marshland River and Esten Lake. There has been no extraction from this deposit to date. However, a large test hole has been dug exposing about 10 feet (3 m) of sand and gravel. A gradation performed on a channel sample from the exposed face gave 30 percent gravel (Figure 3a).

The deposit occupies 175 acres (71 ha), of which 150 acres (61 ha) are available for extractive purposes. Assuming an average depth of approximately 15 feet (5 m), there are an estimated 6 million tons (5 million tonnes) of sand and gravel. Access to the area is provided by a logging road. Because of existing access and proximity to the townsite, this deposit has been selected for possible resource protection.

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

There are numerous deposits which have been classed as Resource Areas of Secondary Significance. The first of these is a large outwash deposit along Highway 108 in central Bouck Township. This deposit has been extensively worked. Because of previous extraction and cultural constraints, there is little usable material left. There are major gravel pockets within the deposit, but with the exception of pits 5 and 10, these pockets appear to have been depleted. Remaining parts of the deposit are of a sandy nature. Other similar deposits include two outwash deposits along Highway 108 near the boundary of Bouck and Gunterman Townships, a gravel deposit adjacent to the south end of Quirke Lake and eight secondary sand and gravel deposits near Highway 108 situated south and east of the townsite in Joubin, Esten, and Proctor Townships.

The secondary deposits around Gullbeak, McCabe, Hough, and May Lakes, as well as one north of Dunlop Lake, have no extractive activity to date. These deposits have been explored to varying degrees, usually related to the ease of access. Classification of the deposits in Joubin Township is based on data from a map titled "Granular Materials Investigation in the Elliot Lake-Quirke Lake Area" (Smith and Belcher 1957), and on observations by the local aggregate producers. A 3-foot (1 m) deep test hole was placed in the outwash deposit west of Gullbeak Lake and exposed fine to medium gravel. A sample taken of this material revealed 68 percent gravel (Figure 4, EL-TH-3). Similar material may be present elsewhere in the deposit. Before extraction of any previously unmined secondary deposit is commenced, detailed testing and evaluation with respect to quality and quantity of the aggregate are advised.

SAND AND GRAVEL RESOURCE AREAS OF TERTIARY SIGNIFICANCE

Most tertiary deposits shown on Map 2 have

limited available resources, although they may be able to supply aggregate for local use. The outwash deposits along Magog and Crooked Creeks in McGiverin Township may even qualify as deposits of secondary significance if satisactory evidence of quality and quantity can be established. But in the absence of such information, the deposit is classed as a sand deposit.

BEDROCK GEOLOGY

There are four major bedrock units in the Elliot Lake Area. The first and oldest consists of mafic to intermediate metavolcanic and metasedimentary rocks (Robertson 1968). They are represented by Rock Types A and B on Map 3. These rock types tend to weather quickly. Consequently, they may not be suitable for the production of crushed stone.

The second unit, Rock Type C, consists of two types of granitic rock. The first is a pink to grey granodiorite and the second is a slightly radioactive, red quartz monzonite (Robertson 1968). Neither of these rocks have been selected as a bedrock resource. The granodiorite tends to be variable while the monzonite is of a more consistent quality, although, slightly radioactive. The granitic rocks may be suitable for extractive development, but site specific testing of the quality of the rock is advised.

The third bedrock unit is made up of a series of Huronian sediments folded about the Quirke syncline (Robertson 1968). These rocks range in composition from greywackes, mudstones, arenites and radioactive conglomerates to limestones. The Huronian rocks have been labelled Rock Types D to P on Map 3, and have not been selected for possible resource protection. Each rock type has been found to either contain deleterious fractions, be too hard for practical quarrying purposes or to contain significant levels of radioactive mineralization.

The fourth bedrock unit has been selected for possible bedrock protection. The Nipissing Diabase (Rock Type R) is a coarse-grained, dioritic, quartz diabase. This diabase unit appears to be free of olivine which may cause premature weathering and breakdown in construction materials. All diabase units which have thin drift cover have been selected for possible resource protection. Crushed stone of diabase origin might be acceptable for most construction purposes. A detailed petrographic analysis and evaluation of the material is advised before any extraction is commenced.

SELECTED BEDROCK RESOURCE AREA 1

A total of 12,000 acres (4850 ha) of Nipissing Diabase (Rock Type R) with less than 3 feet (1 m) of drift cover has been selected for possible resource protection. The area currently available for extraction is approximately 11,000 acres (4450 ha). Assuming a quarriable depth of 60 feet (18 m), there are 2700 million tons (2450 million tonnes) of diabase rock available for crushing.

Major areas selected for possible resource protection are located along the northern boundary of the map area; north of Kings Lake in Joubin Township; around Nordic Lake near the south edge of the Elliot Lake townsite; and in McGiverin and Esten Townships. There are also scattered deposits of lesser importance.

SUMMARY

The Town of Elliot Lake appears to have sufficient aggregate resources to meet local needs, including those of the existing mining companies. The physical quality of these deposits is excellent. Five outwash deposits have been selected for possible resource protection at the primary level. Many of the secondary deposits also have significant quantities of good to excellent quality sand and gravel.

The Elliot Lake Area is underlain by four major units of Precambrian rock; one of which has been selected for possible resource protection. The Nipissing Diabase may be suitable for the production of crushed stone products for most construction uses.

Enquiries regarding the Aggregate Resources Inventory of the Town of Elliot Lake should be directed to the Ontario Ministry of Natural Resources either at Blind River District Office, 62 Queen Street Box 190, Blind River, Ontario, P0R 1B0 (705) 356-2234 or at the Northeastern Region Office, 199 Larch Street, Sudbury, Ontario, P3E 5P9 (705) 675-4120.

TABLE 1 | TOTAL SAND AND GRAVEL RESOURCES, TOWN OF ELLIOT LAKE

1 CLASS NO.	2 DEPOSIT TYPE (see Appendix C)	3 AREAL EXTENT Acres (Hectares)	4 ORIGINAL TONNAGE Millions of Tons (Tonnes)
1	G-OW	770 (310)	41 (37)
2	G-OW	1460 (590)	60 (54)
	S-OW	2140 (870)	62 (56)
3	G-OW	1030 (415)	22 (20)
	S-OW	4450 (1800)	75 (68)
4	S-OW	180 (73)	2 (2)
		10,000 (4050)	260 (236)

* Does not include estimates of material contained in Magog Creek Deposits in McGiverin Township or the deposits within the urban development boundary surrounding the townsite of Elliot Lake.

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2 | SAND AND GRAVEL PITS, TOWN OF ELLIOT LAKE*

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
1	–	Ministry of Transportation and Communications (M.T.C.)			5 (1.5)	–	
2	R25-2	K.J. Beamish Const.			10-15 (3-5)	50	active
3	R25-13 & 14	M.T.C.			5 (1.5)	50	
4	R25-17 & 12	Rio Algom Ltd.			20-25 (6-8)	60-70	active
5	E8-72	Denison Mines Ltd.			15-25 (5-8)	–	active
6	E8-26	Denison Mines Ltd.			12-15 (4-5)	–	
7	–	Denison Mines Ltd.			5-15 (1.5-5)	–	
8	–	Unknown			–	–	
9	E8-22	M.T.C.			6-10 (2-3)	5-40	
10	E8-21	W. Albert			25 (8)	–	active
11	E8-53	M.T.C.			–	–	
12	E8-32	M.T.C.			15 (5)	–	
13	–	M.T.C.			–	–	
14	E8-34	M.T.C.			10 (3)	50-70	
15	E8-19	Unknown			–	–	
16	–	W. Farquhar			6-12 (2-4)	60-65	active
17	E8-80	G. Hope			10-18 (3-5)	30-35	active

TABLE 2 | SAND AND GRAVEL PITS, TOWN OF ELLIOT LAKE*

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
18	–	W. Farquhar			15-20 (5-6)	–	
19	E8-64 & 65	Unknown			5-10 (1.5-3)	–	
20	E8-50	W. Albert			12-18 (4-6)	20-25	active
21	E8-82	A. Forming			3-12 (1-4)	50-75	active
22	E8-83	Matthew's Group			8 (2)	30-35	active
23	E8-73	Matthew's Group			8 (2)	60-65	
24	–	Denison Mines Ltd.			20 (6)	–	till
25	–	Denison Mines Ltd.			10-15 (3-5)	–	till
26	–	Rio Algom Ltd.			–	–	till
27	–	Rio Algom Ltd.			15 (5)	–	till
28	–	Rio Algom Ltd.			–	–	till
29	–	Rio Algom Ltd.			10 (3)	–	till
30	–	Denison Mines Ltd.			–	–	
31	–	Town of Elliot Lake			–	–	
32	–	Unknown			–	10	
33	–	Rio Algom Ltd.			–	–	
34	E8-14	Rio Algom Ltd.			15-30 (5-9)	30-35	
35	–	Unknown			–	–	
36	E8-68	Unknown			–	–	water filled

TABLE 2 | SAND AND GRAVEL PITS, TOWN OF ELLIOT LAKE*

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
37	E8-69	K.J. Beamish Const.			5-40 (1.5-12)	40-50	active
38	–	Ministry of Natural Resources (M.N.R.)			10 (3)	–	
39	E8-52	M.N.R.			35 (11)	30-35	
40	–	M.N.R.			–	–	
41	–	Matthew's Group			40 (12)	30	
42	E8-3 & 43	W. Farquhar			10-15 (3-5)	–	
43	E8-4	M.T.C.			9-25 (3-8)	–	
44	E8-39	W. Albert			–	<1	
45	–	Greg's Diving Service			10 (3)	30	unopened, test hole
46	E8-62 & 74	W. Farquhar			20 (6)	40	active
47	E8-76	Matthew's Group			10-15 (3-5)	0-70	active
48	E8-2	M.T.C.			20-30 (6-9)	50-70	inactive
49	E8-1	M.T.C.			20 (6)	30-65	
50	E8-42	M.N.R.			5 (1.5)	–	inactive
51	E8-33 & 56	M.T.C.			10 (3)	–	
52	–	Matthew's Group			3-12 (1-4)	dominantly sand	
53	–	W. Farquhar			3-5 (1-1.5)	<30	

TABLE 2 | SAND AND GRAVEL PITS, TOWN OF ELLIOT LAKE*

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
54	–	Unknown			–	–	
55	–	Unknown			10-20 (3-6)	–	
56	–	Unknown			10 (3)	–	
57	E8-9	Unknown			–	–	
58	E8-30	Unknown			–	–	
59	E8-31	Unknown			15 (5)	dominantly sand	
60	–	Unknown			6-9 (2-3)	–	

* Lots and concessions are not applicable in this area.

TABLE 3 | SELECTED SAND AND GRAVEL RESOURCE AREAS, TOWN OF ELLIOT LAKE

1 **DEPOSIT NO.**	2 **UNLICENCED AREA** Acres (Hectares)	3 **CULTURAL SETBACKS** Acres (Hectares)	4 **EXTRACTED AREA** Acres (Hectares)	5 **AVAILABLE AREA** Acres (Hectares)	6 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	7 **AVAILABLE AGGREGATE** Millions of Tons (Tonnes)
1	120 (48)	58 (23)	2 (2)	60 (24)	25 (8)	4 (4)
2	120 (48)	20 (8)	15 (6)	85 (34)	25 (8)	5 (4)
3	950 (385)	280 (113)	20 (8)	650 (265)	18 (5)	29 (26)
4	305 (123)	30 (12)	0 (0)	275 (111)	20 (6)	14 (13)
5	175 (71)	25 (10)	0 (0)	150 (61)	15 (5)	6 (5)
	1670 (680)	415 (168)	37 (15)	1220 (495)		58 (53)

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, TOWN OF ELLIOT LAKE*

1 DRIFT THICKNESS Feet (Metres)	2 BEDROCK LITHOLOGY	3 QUARRIABLE THICKNESS Feet (Metres)	4 AREAL EXTENT Acres (Hectares)	5 ORIGINAL TONNAGE Millions of Tons (Tonnes)
0-3 (0-1)	Rock Type A	60 (18)	1340 (540)	295 (270)
3-25 (1-8)	Rock Type A	60 (18)	180 (73)	40 (36)
			1520 (620)	335 (305)
0-3 (0-1)	Rock Type B	60 (18)	4850 (1960)	1080 (980)
3-25 (1-8)	Rock Type B	60 (18)	1450 (590)	320 (290)
			6300 (2550)	1400 (1270)
0-3 (0-1)	Rock Type C	60 (18)	45,500 (18 400)	10,100 (9200)
3-25 (1-8)	Rock Type C	60 (18)	16,200 (6600)	3600 (3250)
			62,000 (25 000)	13,700 (12 400)
0-3 (0-1)	Rock Type D	60 (18)	345 (140)	76 (69)
0-3 (0-1)	Rock Type E	60 (18)	1760 (710)	380 (345)
3-25 (1-8)	Rock Type E	60 (18)	3400 (1380)	730 (660)
			5200 (2100)	1110 (1010)

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, TOWN OF ELLIOT LAKE*

1 DRIFT THICKNESS Feet (Metres)	2 BEDROCK LITHOLOGY	3 QUARRIABLE THICKNESS Feet (Metres)	4 AREAL EXTENT Acres (Hectares)	5 ORIGINAL TONNAGE Millions of Tons (Tonnes)
0-3 (0-1)	Rock Type F	60 (18)	300 (121)	65 (59)
3-25 (1-8)	Rock Type F	60 (18)	60 (24)	13 (12)
			360 (146)	78 (71)
0-3 (0-1)	Rock Type G	60 (18)	265 (107)	57 (52)
3-25 (1-8)	Rock Type G	60 (18)	145 (59)	31 (28)
			410 (166)	88 (80)
0-3 (0-1)	Rock Type H	60 (18)	850 (345)	184 (167)
3-25 (1-8)	Rock Type H	60 (18)	2200 (890)	475 (430)
			3050 (1230)	660 (600)
0-3 (0-1)	Rock Type J	60 (18)	6900 (2700)	1490 (1350)
3-25 (1-8)	Rock Type J	60 (18)	6000 (2430)	1300 (1180)
			12,900 (5200)	2800 (2550)
0-3 (0-1)	Rock Type K	60 (18)	3800 (1540)	820 (740)
3-25 (1-8)	Rock Type K	60 (18)	1970 (800)	435 (385)
			5800 (2350)	1240 (1120)

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, TOWN OF ELLIOT LAKE*

1 DRIFT THICKNESS Feet (Metres)	2 BEDROCK LITHOLOGY	3 QUARRIABLE THICKNESS Feet (Metres)	4 AREAL EXTENT Acres (Hectares)	5 ORIGINAL TONNAGE Millions of Tons (Tonnes)
0-3 (0-1)	Rock Type L	60 (18)	3900 (1580)	840 (760)
3-25 (1-8)	Rock Type L	60 (18)	2320 (940)	500 (455)
			6200 (2500)	1340 (1220)
0-3 (0-1)	Rock Type M	60 (18)	29,500 (11 900)	6400 (5800)
3-25 (1-8)	Rock Type M	60 (18)	6000 (2430)	1300 (1180)
			35,500 (14 400)	7700 (7000)
0-3 (0-1)	Rock Type N	60 (18)	2050 (830)	445 (405)
3-25 (1-8)	Rock Type N	60 (18)	300 (121)	65 (59)
			2350 (950)	510 (465)
0-3 (0-1)	Rock Type P	60 (18)	190 (77)	41 (37)
3-25 (1-8)	Rock Type P	60 (18)	80 (32)	17 (15)
			270 (109)	58 (53)
0-3 (0-1)	Rock Type R	60 (18)	15,000 (6100)	3700 (3350)
3-25 (1-8)	Rock Type R	60 (18)	4100 (1660)	1010 (920)
			19,100 (7700)	4700 (4250)
			161,000 (65 000)	36,000 (32 500)

* Does not inclue estimate of bedrock resources within the urban development boundary surrounding the townsite of Elliot Lake.

TABLE 5 | QUARRIES, TOWN OF ELLIOT LAKE

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 FACE HEIGHT Feet (Metres)	7 QUARRY STATUS

– NONE –

TABLE 6 | SELECTED BEDROCK RESOURCE AREAS, TOWN OF ELLIOT LAKE

1 DEPOSIT NO.	2 DEPTH OF OVERBURDEN Feet (Metres)	3 AREA Acres (Hectares)	4 CULTURAL SETBACKS Acres (Hectares)	5 EXTRACTED AREA Acres (Hectares)	6 AVAILABLE AREA Acres (Hectares)	7 ESTIMATED QUARRIABLE THICKNESS Feet (Metres)	8 AVAILABLE RESOURCES Millions of Tons (Tonnes)
1	0-3 (0-1)	12,000 (4850)	1000 (405)	0 (0)	11,000 (4450)	60 (18)	2700 (2450)

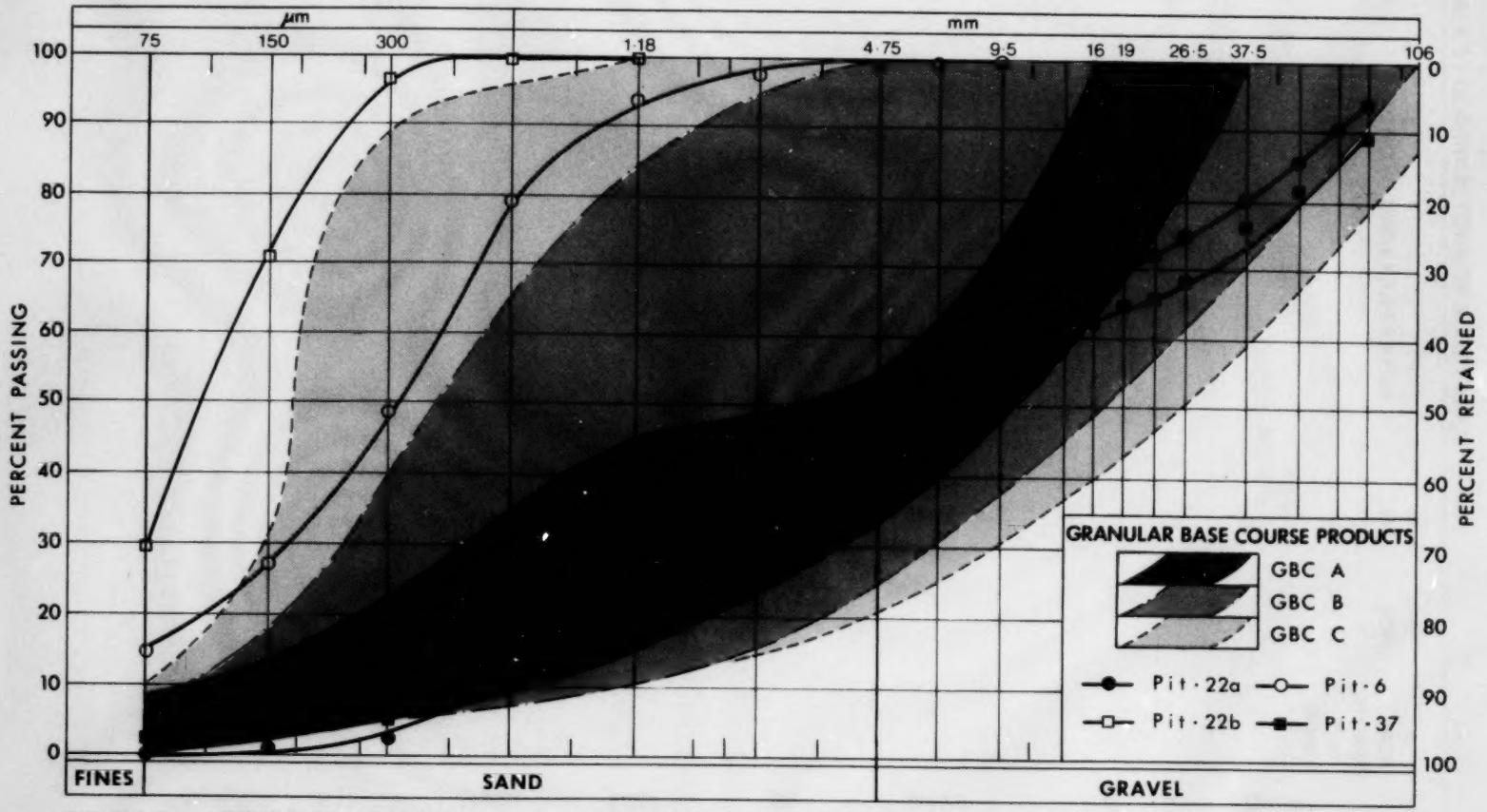


FIGURE 2a: AGGREGATE GRADING CURVES, THE TOWN OF ELLIOT LAKE;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

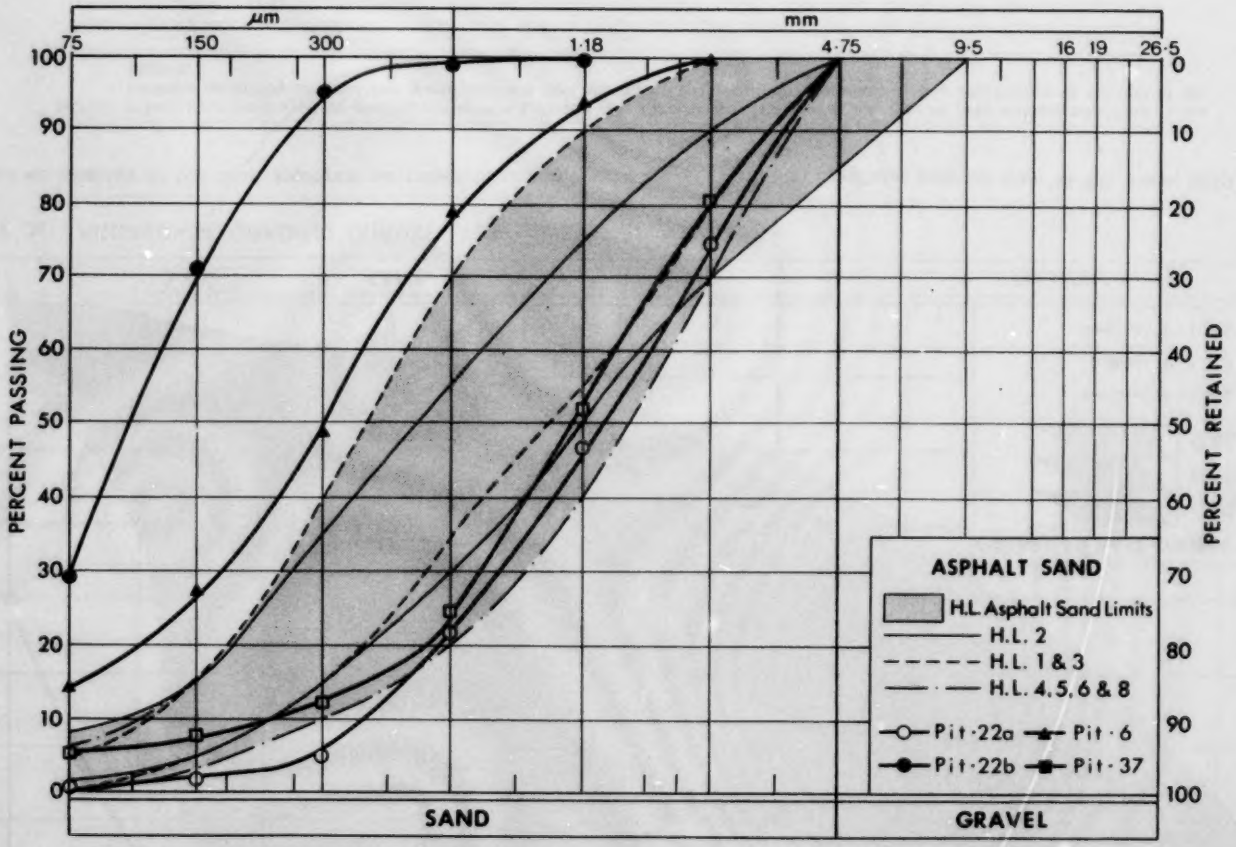


FIGURE 2b: AGGREGATE GRADING CURVES, THE TOWN OF ELLIOT LAKE;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1003, 1979).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

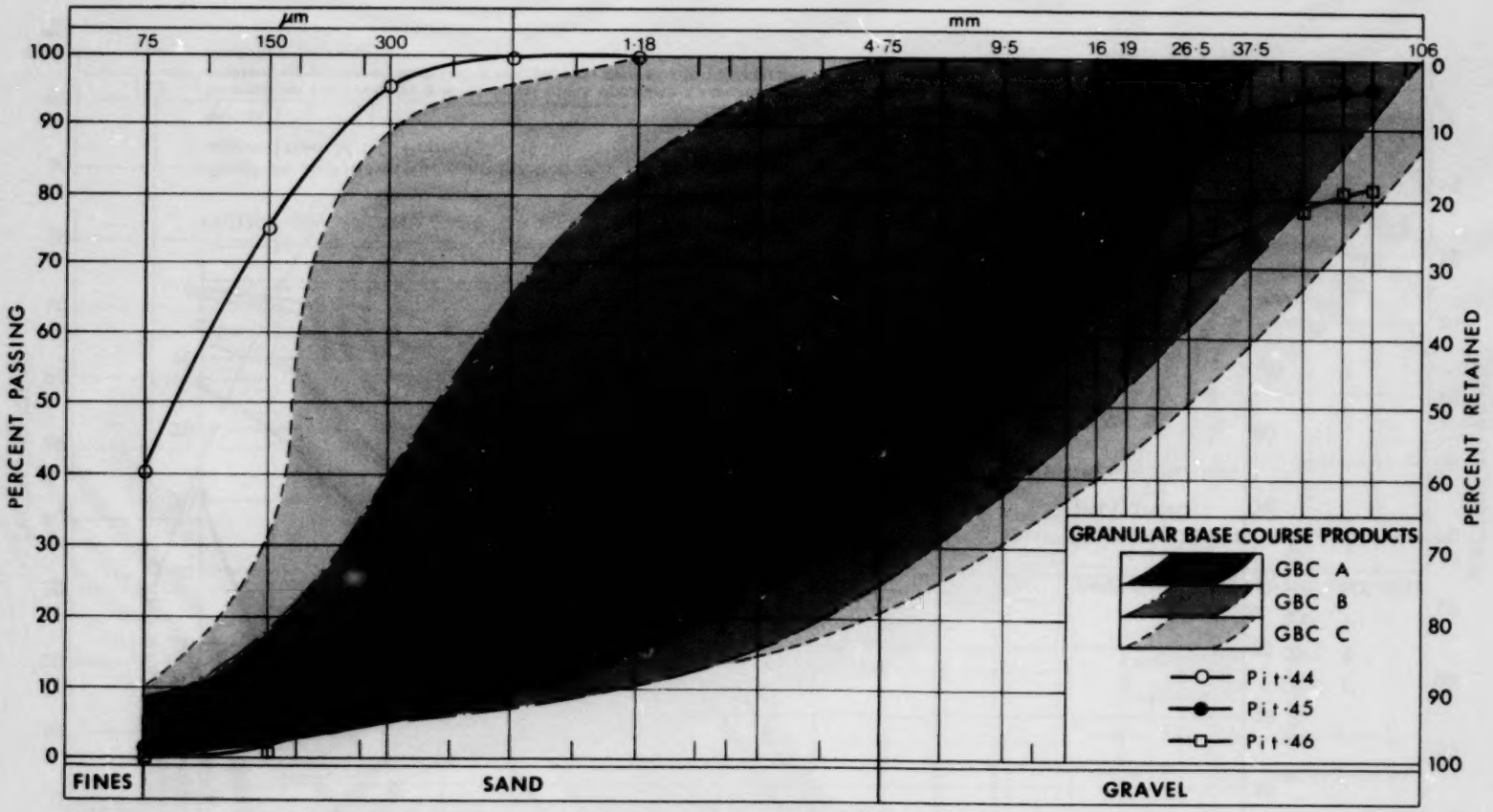


FIGURE 3a: AGGREGATE GRADING CURVES, THE TOWN OF ELLIOT LAKE;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

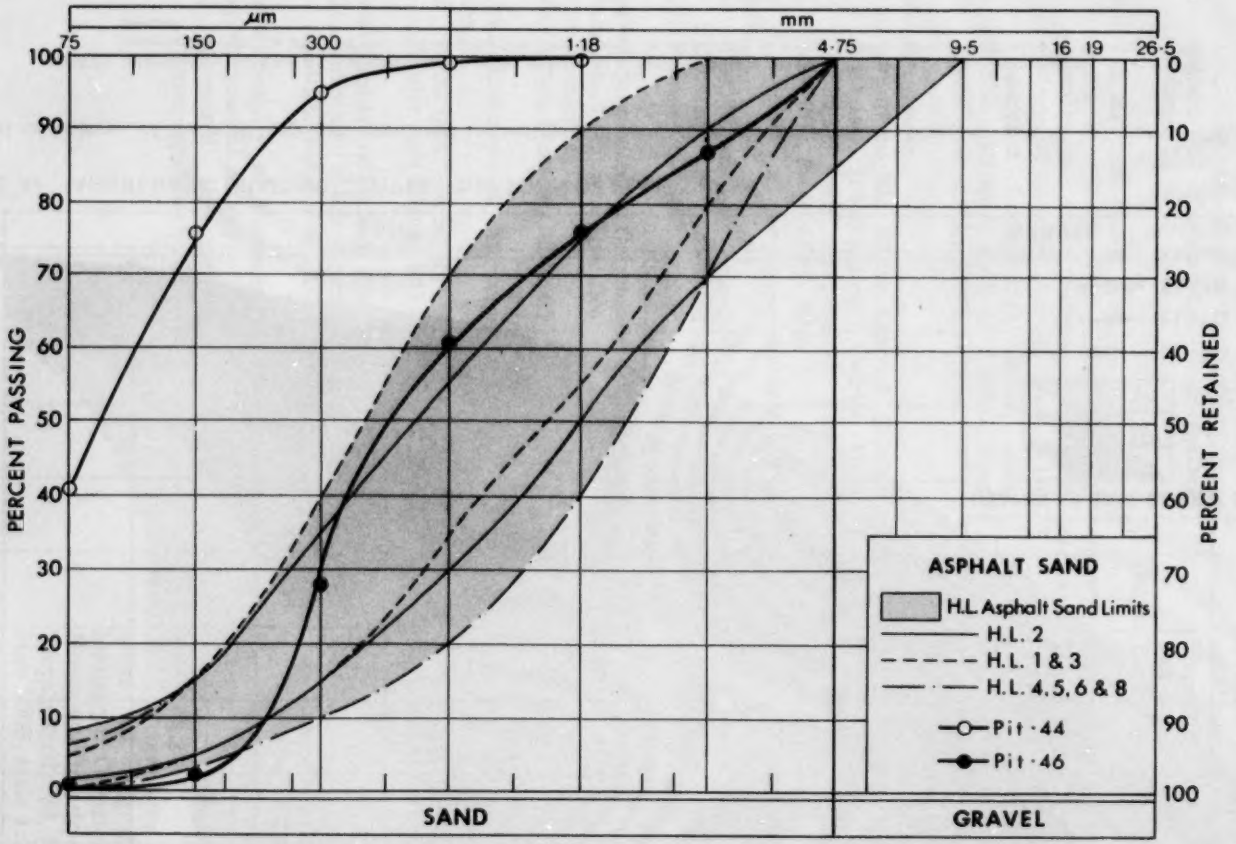


FIGURE 3b: AGGREGATE GRADING CURVES, THE TOWN OF ELLIOT LAKE;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1003, 1979).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

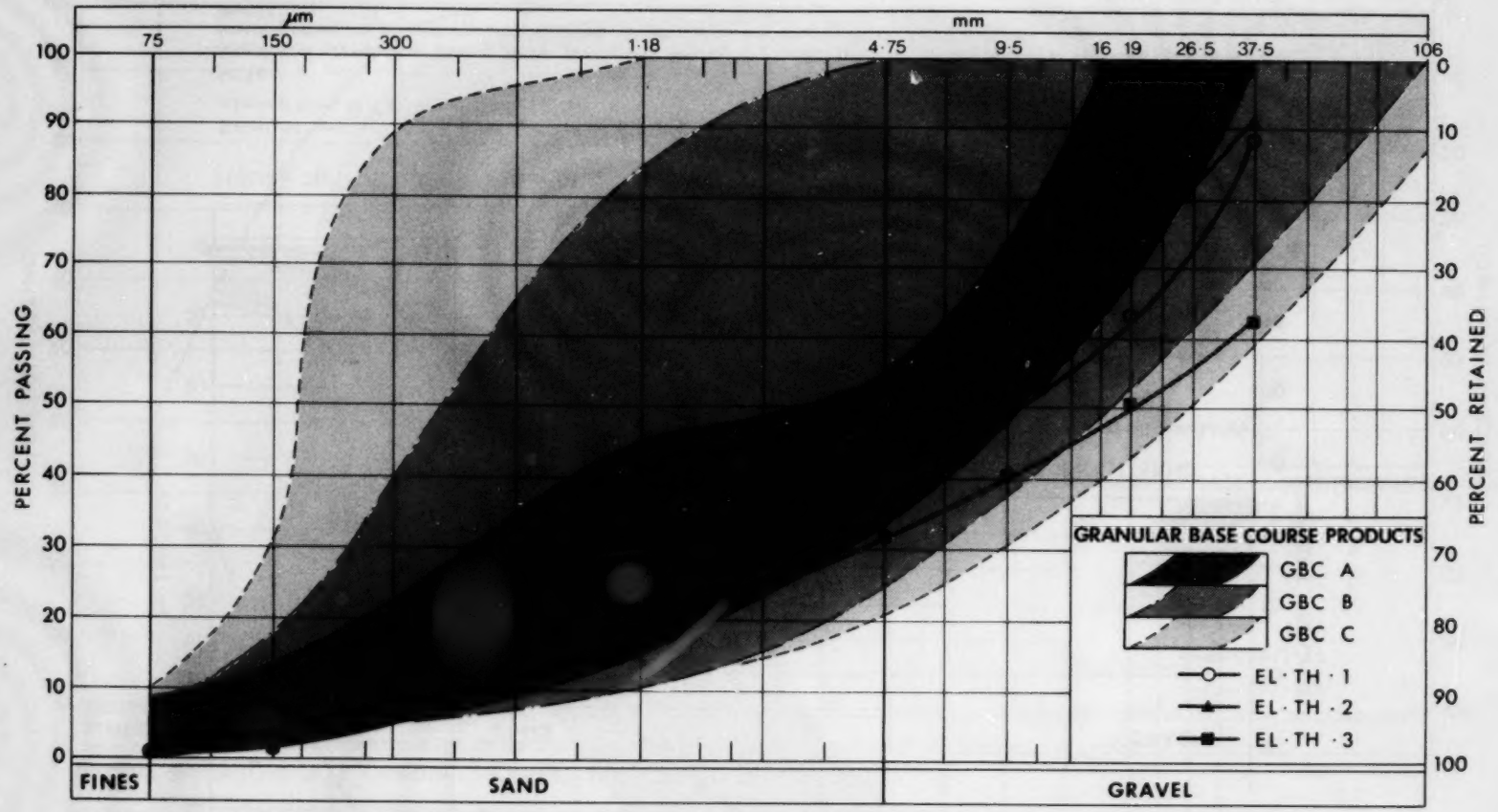


FIGURE 4: AGGREGATE GRADING CURVES, THE TOWN OF ELLIOT LAKE;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

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APPENDIX B - GLOSSARY

ABRASION RESISTANCE

Tests such as the Los Angeles Abrasion Test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

ABSORPTION CAPACITY

Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

AGGREGATE

Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

ALKALI-AGGREGATE REACTION

A chemical reaction between the alkalies of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

BLENDING

Required in cases of extreme coarseness, fineness or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

CLAST

An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering of a larger rock mass. Synonyms include particle and fragment.

CRUSHABLE AGGREGATE

Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

DELETERIOUS LITHOLOGY

A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone, and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions. Similarly, highly weathered, very porous and friable rock can restrict the quality of the aggregate.

DOLOSTONE

A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

DRIFT

A general term for all unconsolidated rock debris transported from one place and deposited in another; distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

DRUMLIN

A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were deposited beneath an advancing ice sheet, and were shaped by its flow.

EOLIAN

Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

FINES

A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

GNEISS

A coarse textured metamorphic rock with the minerals arranged in parallel streaks or bands, but lacking schistosity. Gneiss is relatively rich in feldspar. Other common minerals found in this rock include quartz, mica, amphibole and garnet.

GRADATION

The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulders	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

GRANITE

Is a coarse-grained light coloured rock that ordinarily has an even texture and is composed of quartz, and feldspar with either mica, hornblende or both.

GRANULAR BASE COURSE

Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability, and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

HOT-LAID (OR ASPHALTIC) AGGREGATE

Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3, and 4), or as binder course (H.L. 2, 6, and 8) used to bind the surface course to the underlying granular base course.

LITHOLOGY

The description of rocks on the basis of such characteristics as color, structure, mineralogic composition, and grain size. Generally, the description of the physical character of a rock.

MAGNESIUM SULPHATE SOUNDNESS TEST

This test is designed to simulate the action of freezing and thawing on aggregates. Those aggregates which are susceptible will usually breakdown and give high losses in this test.

MELTWATER CHANNEL

A drainage way, usually terraced, produced by water flowing away from a melting glacier margin.

PETROGRAPHIC EXAMINATION

An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of aggregate.

PLEISTOCENE

An Epoch of the recent geological past including the time from approximately 1.8 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

POSSIBLE RESOURCE

Estimates of mineral aggregate material based largely on broad knowledge of the geologic

character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

PRECAMBRIAN

The earliest geologic period extending from the consolidation of the earth's crust to the beginning of the Cambrian.

SHALE

A fine-grained, sedimentary rock formed by the consolidation of clay, silt, or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, silstone, and mudstone.

SOUNDNESS

The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

TILL

Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

WISCONSINAN

Pertaining to the last glacial stage of the Pleistocene Epoch in North America. It began approximately 100,000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

APPENDIX C - GEOLOGY OF SAND AND GRAVEL DEPOSITS

The type, distribution, and extent of sand and gravel deposits in Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100,000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and they can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: Those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

ICE-CONTACT TERRACES (ICT)

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous due to extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive due to the variability of the deposits both in terms of quality and grain size distribution.

KAMES (K)

Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits, producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good-quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the presence of excess fines (silt- and clay-sized particles).

ESKERS (E)

Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

UNDIFFERENTIATED ICE-CONTACT STRATIFIED DRIFT (IC)

This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits due to their lack of continuity and grain-size variability. They are given a qualitative rating based on existing pit and other subsurface data.

OUTWASH (OW)

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the glacier. They occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

ALLUVIUM (AL)

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and it has generally low value due to the presence of excess silt- and clay-sized material. There are no large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

GLACIOLACUSTRINE BEACH DEPOSITS (LB)

These are a relatively narrow, linear feature formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the underlying material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

GLACIOLACUSTRINE DELTAS (LD)

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

GLACIOLACUSTRINE PLAIN (LP)

The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources due to their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

END MORAINES (EM)

These are belts of glacial drift deposited at, and parallel to, glacier margins. They commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best resource areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

WINDBLOWN FORMS (WD)

Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments are almost invariably composed of fine to coarse sand and are usually well sorted. The probability of locating crushable aggregate in windblown deposits is very low.

APPENDIX D - GEOLOGY OF BEDROCK DEPOSITS
(Modified after Robertson 1961, 1963, 1968, 1970, 1977)

MAFIC TO INTERMEDIATE METAVOLCANICS (EARLY PRECAMBRIAN)

Rock Type A: Consists of mafic metavolcanic flows. For the most part, the mafic flows are massive, amygdaloidal, porphyritic or pillowed. Basalt is a common mafic metavolcanic rock. Agglomerates, tuffs and minor amounts of metasediments are also present.

METASEDIMENTS (EARLY PRECAMBRIAN)

Rock Type B: Consists predominantly of greywacke and conglomerate. Minor amounts of iron formation are also present.

FELSIC INTRUSIVE ROCKS (EARLY PRECAMBRIAN)

Rock Type C: Pink to grey, medium- to coarse-grained, gneissic to massive granodiorite, intruded by a massive, coarse-grained, equigranular to porphyritic red quartz monzonite. The monzonite is slightly radioactive.

HURONIAN SUPERGROUP (MIDDLE PRECAMBRIAN)

Rock Type D: Volcanic rocks, including basalt, andesite, amphibolite, minor rhyolite and intercalated sedimentary rocks.

ELLLIOT LAKE GROUP

Rock Type E: Matinenda Formation: Well washed, white, fine- to medium-grained, feldspathic quartzite with uranium mineralization. Also includes arkose and conglomerate.

Rock Type F: McKim Formation: Siltstone, argillite and quartzite.

HOUGH LAKE GROUP

Rock Type G: Ramsay Lake Formation: Polymictic boulder conglomerate containing boulders, cobbles, and pebbles of granite, quartzite, and greenstone, and fragments of quartz and feldspar set in a matrix that grades upwards from a siliceous greywacke to a siltstone.

Rock Type H: Pecors Formation: Finely-laminated siltstone or argillite interlayered with greywacke.

Rock Type J: Mississagi Formation: Medium- to coarse-grained yellow-green to grey, feldspathic quartzite and conglomerate.

QUIRKE LAKE GROUP

Rock Type K: Bruce Formation: A conglomerate consisting of pebbles and boulders of granite, granitic gneiss, greenstone and quartzite with fragments of quartz, chert, jasper, and white feldspar in a medium- to coarse-grained greywacke matrix. Espanola Formation: Alternating beds of cream-coloured limestone and grey calcareous siltstone.

Rock Type L: Serpent Formation: massive, white, feldspathic quartzite grading upwards to a pinkish, silty quartzite and quartzite with argillitic and conglomeritic bands. This unit is topped by a coarse-grained, massive, arkosic grit with a slightly calcareous cement.

COBALT GROUP

Rock Type M: Gowganda Formation: A conglomerate with predominantly red granite boulders. Gneiss, greenstone, and diabase are also common. The matrix consists of fine- to coarse-grained, dark-green to black greywacke. Also present are finely-laminated siltstone and quartzite.

Rock Type N: Lorrain Formation: White quartzite with interbedded quartz-chert-jasper-conglomerate. Arkose and conglomerate are also present.

Rock Type P: Gordon Lake Formation: Sedimentary sequence of siltstone, argillite, and quartzite.

MAFIC INTRUSIVE ROCKS (MIDDLE PRECAMBRIAN)

Rock Type R: Nipissing Diabase: Quartz diabase, gabbro, metagabbro, granophyre and gabbro differentiated to diorite.